Forecasting Need and Demand for Home Health Care: a Selective Review

RABINDER K. SHARMA, PhD

A WELL-ARTICULATED THEORY regarding the determinants of home health care (HHC) does not yet exist. Therefore, the measurement and forecasting of HHC needs usually are based on ad hoc assumptions. In this paper, I review the current techniques for forecasting needs and then illustrate these techniques by applying them to Allegheny County in Pennsylvania. I also present and apply a utilization approach to forecasting. This study is directed to health systems agencies (HSAs), which are responsible for health planning within a designated region.

It should be noted that the use of "need" or "demand" as a basis for planning is controversial. The literature on this subject is extensive. My purpose for this study is not to become embroiled in this controversy; rather, it is that both the need and demand approaches contain important information for planners (*1*).

A Brief Overview of Home Health Care

Although the concept of home health care is old indeed, it has only recently engaged the attention of the nation's policymakers and health professionals. As such, the concept and practice of home health care are still in a period of transition. The main impetus behind the current developments in home health care is the concern with mounting hospital costs; HHC is considered to be one avenue for controlling such costs. Other reasons favoring HHC include its psychological benefits to the client, its humanistic and holistic nature, its personalized services to fit a client's needs, and its reduction of the number of physician and hospital visits (*2*).

In general, HHC is the delivery of health care and health-related services to patients in their homes. However, the nature and extent of services provided are likely to vary, depending on the State and the organization providing the services. Thus, it is important to define the nature and scope of home health services in any particular region. Forecasters of need or demand should consider the prevailing definition, as well as anticipated changes in the definition over the forecast period. In practice, this task is not easy because of fragmentation of services and lack of coordination. The techniques for forecasting that I review do not depend on any particular view of home health care.

Current Forecasting Techniques

The basic information required to apply the techniques reviewed here is a forecast of either total population or population by age and sex; particularly important in this context is the so-called local area population forecast. Local area is a specific geographic subdivision, such as a State or county. Since this paper is addressed to health systems agencies, the local area of interest is

Dr. Sharma is assistant professor of public health, Graduate School of Public Health, and assistant professor of public policy, Graduate School of Public and International Affairs, University of Pittsburgh. Tearsheet requests to Dr. Sharma at the Graduate School of Public Health, University of Pittsburgh, Pittsburgh, Pa. 15261.

either an individual county or groups of counties. A number of techniques are available for forecasting local area populations, each subject to various limitations. A guide to these techniques has been published by the Bureau of the Census (*3*). The guide also contains a step by step illustration of a population forecasting technique. This technique was used to project the population of Allegheny County by age and sex, and these projections are used in this study to illustrate the application of various methods for forecasting HHC need and demand.

It must be emphasized that assumptions and judgments are critical in forecasting (*4,5*). Since the future is unknown and unknowable, the validity of a forecast is always open to challenge before the forecast date. If the forecasts are used for health planning, the critical influence of judgments and assumptions on numerical calculations must be acknowledged explicitly.

In addition to the utilization approach, the following three forecasting models are reviewed here:

- HSA/SP model: Health Systems Agency of Southwestern Pennsylvania,
- Florida model: Florida State Department of Health and Rehabilitative Services, and
- Rhode Island model: Rhode Island Department of Community Affairs.

Each approach is studied in terms of its model specifications, that is, underlying basic assumptions, description of the forecasting model, and the variables used. The models are then illustrated by application to data from Allegheny County, primarily to facilitate understanding of these models.

HSA/SP model. This model (*6*) is based on the assumption that the need for home health care is essentially a derived need based on a certain proportion of (*a*) hospital admissions and (*b*) patients entering HHC from other sources as a direct factor of (*a*).

The following equation, embodying the preceding assumption, further elucidates the model:

$$N = (HAR \times K_1) \times K_2 \quad [1]$$

where

N = need for home health care, measured as a percentage of the total population
HAR = hospital admission rate
K_1 = constant 1, denoting the percentage of hospital admissions transferred to HHC
K_2 = constant 2, which is a multiple of K_1 denoting the number of patients entering from nonhospital sources

Application. For projecting HHC needs for Allegheny County for 1985, HSA/SP uses the following values for the variables in equation 1:

HAR = 172.8 per 1,000 population
K_1 = 10 percent (or .10)
K_2 = 2

Although the value for HAR is based on empirical data, the values of K_1 and K_2 are based mostly on

intuitive judgments. An earlier forecast produced by the Health Systems Agency of Southwestern Pennsylvania set the value of K_1 at 4 percent. There is no demonstrable evidence in support of either value.

Substituting the above values in equation 1:

$$N = (.1728 \times .10) \times 2$$
$$= (.01728) \times 2$$
$$= .03456 \text{ or } 3.4 \text{ percent}$$

To calculate the number of persons needing HHC, a forecast of the total population for a target date is required. The forecasted total population is then multiplied by .03456 to arrive at the number of persons who will be in need of HHC. For example, using the HSA/SP figures, the projected 1985 need for Allegheny County can be calculated as follows:

$$N_{1985} = (\text{forecasted total population, 1985}) \times (.03456)$$
$$= (1{,}507{,}251) \times (.03456)$$
$$= 52{,}090$$

Florida model. This model (*7*) is essentially a modification of the basic HSA/SP model to take account of the fact that hospital admissions and discharges for the elderly (65 years and over) differ significantly from those for the younger population (under age 65). The underlying assumptions, therefore, are essentially the same as for the HSA/SP model. The Florida formula for calculating the percentage of the total population needing HHC is:

$$N_{r\,HHC} = [Ar_e \times \%e) + (Ar_{ne} \times \%ne)] \times (K_1) \times (K_2) \quad [2]$$

where

$N_{r\,HHC}$ = need rate for HHC, as a percentage of the total population
Ar_e = admissions rate to the hospital for those age 65 and older
$\%_e$ = percentage of those age 65 and older within the county
Ar_{ne} = admissions rate to the hospital for the nonelderly (under 65)
$\%_{ne}$ = percentage of the population under age 65 within the county
K_1 = constant 1, denoting the percentage of hospital admissions transferred to HHC
K_2 = constant 2, which is a multiple of K_1, denoting the number of patients entering from nonhospital sources

Application. To use the Florida formula, the admissions rate must be broken down by age. Since this information is not available, regional information (as shown in table 1) is used to derive the necessary rates by age for Allegheny County.

For the northeast region, the 1976 discharge rate for all ages was 154.1, while the rate for Allegheny County was 172.8 per 1,000. The total Allegheny County rate was, therefore, about 12 percent higher than the northeast regional rate. The regional admissions rate is, therefore, inflated proportionately to take into account the higher Allegheny County rate.

To derive the admissions rate for the under-65 age group, the calculation would proceed as follows:

1. 172.8 for 100 percent (admissions rate for Allegheny County)
2. 370.5 for 12.6 percent (estimated admissions rate for Allegheny County for the 65 and over age group who represented 12.6 percent of the total Allegheny County population in 1976)
3. Admissions rate for the under-65 age group who comprise 87.4 percent of the population

$$= \frac{172.8 - 370.5\ (.126)}{.874}$$
$$= \frac{172.8 - 46.7}{.874}$$
$$= \frac{126.1}{.874}$$
$$= 144.3$$

Formula 2 can be applied for calculating home health care need in Allegheny County as follows:

$$N_{r\,HHC}\ 1985 = (.3705) \times .146) + (.1443 \times .854) \times (.10) \times (2)$$
$$= (.054093 + .123232) \times (.10) \times (2)$$
$$= (.177325) \times (.10) \times (2)$$
$$= .035465 \text{ or } 3.5 \text{ percent}$$

The expected number of HHC patients can then be

Table 1. Discharges from short-stay hospitals per 1,000 population, northeast region, 1976

Age group (years)	*Population (in 1,000s)*	*Discharges per 1,000 population*
0–14	11,457	68.3
15–44	21,098	142.7
45–64	10,864	179.6
65 and over	5,359	330.8
Total	48,778	154.1

SOURCE: National Center for Health Statistics: Utilization of short-stay hospitals. Vital and Health Statistics, Series 13, No. 37, 1978, pp. 31 and 64.

determined by multiplying the forecasted total population by .035465.

$$N_{r\,HHC} = (\text{forecasted total population, 1985}) \times (.035465)$$
$$= (1{,}507{,}251) \times (.35465)$$
$$= 54{,}355$$

As expected, the Florida model leads to a slightly higher estimate. In other words, the HSA/SP model underestimates the need because it does not take into account the age variations in the admissions rate.

Rhode Island model. Rhode Island's analytical and technical approach (*8*) to measuring home health care needs is the most explicit of the three approaches in its consideration of the medical basis of need assessment. Medical need is a normative assessment of the type and quality of medical care a population should have, given its morbidity patterns. The need for home health care is defined in terms of the health status of the population. This approach contrasts strongly with the other approaches discussed in this study, which are based on the extrapolation from earlier use patterns.

The Rhode Island study attempts to estimate the HHC needs of the elderly. The critical assumption made by the study is that need for HHC is present whenever a person experiences some kind of limitation on his or her major activities. Another assumption made by the study is that the extent of need for HHC varies, depending upon the degree and type of limitation in major activities. The following two variables are used to measure activity limitations:

- Complete restriction of activity in the last 2 weeks because of confinement to bed, due either to injury or illness.
- Restricted activity within the last 2 weeks because of not feeling well. Although these persons are not confined to bed, they are still unable to engage in normal activities because of illness or injury.

The data on these two variables were collected through the medium of a health utilization survey, and this is probably the major drawback on the applicability of this approach to other regions. However, since State-level data are gradually becoming available, this approach may become widespread soon.

The State-level data should in no way be regarded as a substitute for county-level data. In the absence of local area statistics, however, the State-level data can be used, subject to appropriate qualifications.

At the moment, two sources of disability statistics for States are available on a nationwide basis. One source is the publication by the National Center for Health Statistics on "State Estimates of Disability" and the other is the "Survey of Income and Education" (SIE) conducted by the Bureau of Census in 1976 (*9,10*). SIE also allows the user to calculate the standard errors for data of interest. Since the SIE data were not readily available, the NCHS disability estimates were used to illustrate the "health status" approach to forecasting.

Application. The NCHS State disability estimates are based on a composite of synthetic and direct estimates. Synthetic estimates are based on a method (called synthetic estimation) that assumes that a health characteristic for any given State differs from the regional or national characteristic only because the sociodemographic composition of the State population differs from that of the regional or national population. When this assumption is true, the State synthetic estimates are thought to be generally satisfactory. Whenever this assumed relationship among population characteristics does not hold, the synthetic estimates are subject to biases that at present cannot be estimated.

The second component that is added to the synthetic estimate is a direct estimate based on the observed sample units in the small area of interest. The weighted sum of the two components produces a composite estimate. It is not possible, presently, to calculate error in a composite estimate of a characteristic. Finally, it should be stressed that composite estimates are not superior to those based on a probability sample survey conducted in the small area of interest.

The composite estimates of disability for Pennsylvania are presented in table 2. The concept of limitation of activity refers to long-term reduction in activity resulting from chronic disease or impairment. It is defined as the inability to carry on the major activity for one's age-sex group, such as working, keeping house, or going to school; restriction in the amount or kind of major activity; or restriction in other activities such as recreational, church, or civic interests. About 86 percent of the population was not limited in activity, while about 14 percent of the population was limited in activity of either major or other kinds. In table 2, the categories of limitation that would be pertinent to HHC planning are persons limited in amount or kind of major activity (about 7 percent) and, especially, persons unable to carry on major activities (about 4 percent).

These figures can be used to forecast the number of people with activity limitations. This forecast assumes that no significant differences exist between State and county patterns of disability and that the pattern will persist substantially unchanged over the forecast period. These are strong but necessary assumptions that underlie the forecasting approach in this section. The validity

Table 2. Composite estimates of the percentage of persons with limitation of activity due to chronic conditions, by age group and extent of limitation, Pennsylvania, 1974–76 [1]

Age group (years)	Population (in 1,000s)	Percent not limited in activity	Percent with limitation		
			In major or other kind of activity	In amount or kind of major activity	Unable to carry on major activity
Under 45	7,678	94	6	3	1
45–64	2,724	79	21	12	5
65 and over	1,315	57	43	21	17
Total	11,717	86	14	7	4

[1] Except for the population column, which is based on 1975 estimates, all other columns are based on a 3-year average.

SOURCE: reference 9, p. 29.

of these assumptions should be examined at least on a priori basis for each State and county of interest.

The formula used for forecasting can be stated as follows:

$$A_{i,j}^{t+n} = P_i^{t+n} \times a_{i,j}^{t} \quad [3]$$

where

$A_{i,j}$ = forecasted population in age group i with disability of type j

P_i = population in age group i

$a_{i,j}$ = percentage of population in age group i with disability of type j

t = base period

$t+n$ = forecast target date

Table 3 is based on formula 3. For example, the 34,436 persons in the 65 and over age group who were unable to carry on major activities were calculated as follows:

$$A_{65+}^{1985} = 202{,}562 \times .17$$
$$= 34{,}436$$

As stated before, I developed the population forecast for Allegheny County.

The category of "limitation" that is probably directly relevant to HHC planning is the one relating to inability to carry on major activity. The figures in table 3 relate only to noninstitutionalized civilian population. Therefore, a complete forecast would also include, in addition to these figures, an estimate of the number of hospital discharges and patients in long-term care institutions who can be transferred to HHC. The nature and extent of HHC services that are provided will, of course, ultimately depend upon the judgment of medical and health professionals.

Utilization approach. The utilization approach is essentially a variant of demand-based approaches to forecasting. The estimates based on this approach depend upon the actual use or market behavior of the target population. The extrapolation from an observed medical care market implies that the forecast incorporates market constraints and existing access barriers such as income, lack of knowledge, fees, insurance levels, and patient preference that affect the ability of the consumers to translate need into demand. The forecasts also assume a given institutional and socioeconomic structure within which the interactions of consumers, providers, third-party payers, and regulators lead to a particular configuration of utilization.

As used in this study, the utilization approach is subject to two main limitations. First, it assumes that the utilization rates for each population group will remain constant over the forecast interval because data to determine a utilization rate were available only for 1 year. Second, it assumes that factors such as access barriers, income, and physician preferences will not have a differential impact on utilization during the interval. The second assumption imposes a strong limitation on the utilization approach. However, over the short-run periods, institutional and access barriers are

Table 3. A forecast of the number of people with limitation of activity due to chronic conditions, by age group and extent of limitation, Allegheny County, Pa., 1985

Age group (years)	Limited in activity	Limited in amount or kind of major activity	Unable to carry on major activity
Under 45	52,428	26,214	8,738
45–64	65,704	37,545	15,644
65 and over	87,102	42,538	34,436
Total	205,234	106,297	58,818

usually difficult to change; therefore, the utilization approach may yield useful results. Furthermore, as changes occur and new trends emerge, adjustments may be incorporated into the formula.

Application. The following formula is used for projection:

$$U_i^{t+n} = P_i^{t+n} \times Ur_i \quad [4]$$

where

U_i^{t+n} = projected demand by age group i for home health care at time t + n in terms of number of people using HHC

P_i^{t+n} = projected population in age group i at time $t+n$

Ur_i = home health care utilization rate for age group i expressed either in per capita terms or as a percentage of the population in age group i using home health care

Table 4 is based on formula 4. It should be emphasized that data on utilization pertain to hospital-based home health care programs. As such, they predominantly reflect hospital discharges. The projected demand estimates have to be adjusted to take into account those who cannot translate their perceived or unperceived needs into demand because of institutional or socioeconomic barriers or lack of knowledge.

The HSA/SP assumes that a number equal to admissions from hospital discharges enter home health care from community sources. Based on this assumption, the projected number of patients needing home health care in 1985 is 47,516 (23,758 + 23,758). However, if the estimate of community need for HHC is based on the "health status" approach (table 3) the total number of people who will need HHC in 1985 is 82,576 (23,758 + 58,818). The measure of community need used here is the inability to carry on major activity.

Table 4. Fixed utilization rate approach—projecting total demand for home health care—1985

Age group (years) (1)	Projected population, 1985 (2)	Utilization rate (3)	Projected demand, 1985 (4 = 2 × 3)
Under 65	1,186,677	.00439	889
65 and over ...	202,562	.112903	22,869
Total	1,389,239	.....	23,758

NOTE: Utilization rate is calculated as the number of admissions to home health care by age, in 1977, divided by the total population in the respective age groups in 1977.

Comparative Assessment of Approaches

A frequently used classification for distinguishing various methods is that based on demand and need orientations. Need methods are based on a normative evaluation that incorporates the health status and health needs of the population but lacks adjustments for provider and patient preferences and economic and structural constraints. Demand methods are predicated on expected market behavior of the target population and may be only partly responsive to health needs. However, they reflect effective demand as constrained by various market forces ignored by the health status approach.

Forecasts based on need and demand methods will differ considerably, and reliance on only one method is unlikely to achieve HSA policy goals. Since home health care needs are ultimately rooted in the subjective preferences of some groups, it is important to determine whose judgment will count in the final analysis. In the HSA/SP and Florida models, the bases of need formulation are not explicitly defined. The value of constant K_1 (proportion of hospital discharges transferred to home health care) is set at .10. This strategy implicitly assigns weight to physicians in determining needs. The other assumption (that relating to K_2)—about a number equal to admissions from hospitals originating from community sources—is also not explicitly related to a health need profile. No mention is made of the possibility that a certain proportion of the residents of long-term care institutions can be transferred to a home health care program.

The Rhode Island approach has much to recommend it. First, it articulates the pattern of illness that generates the need for home health care. Second, the Rhode Island model is a population-based need approach, since the morbidity rates can be multiplied by the forecasted population to yield an expected morbidity profile for the population of an HSA region. Third, the model assigns considerable weight to the perceived needs of the consumer in determination of home health care needs.

One use of a need-based approach is the development of criteria for evaluating the existing home health care industry. However, since this approach does not take into account consumer and provider preference as well as resource constraints, it is not suitable by itself for designing strategies for change. On the other hand, demand-based approaches are helpful in depicting current utilization experience as well as the underlying causal mechanism. This depiction may shed some light on policy for increasing use of current services. The dependence of such approaches on prevailing market structure and institutional and socioeconomic context

means that they cannot be used for evaluating the home health care system performance.

Two criticisms are usually leveled at demand approaches. First, it is charged that demand for health care is not measurable. Although this limitation has not been demonstrated conclusively, a much more serious criticism is that utilization appears to be more responsive to the supply of services rather than demand (*11*). This criticism applies with special force to physicians' services. Within the context of the home health care industry, supplier-induced demand can lead to the following consequences: (*a*) excessive number of visits and (*b*) increase in the number of admissions to HHC depending on physicians' preferences or admissions policies of home health care agencies. Supplier-induced demand can be curtailed only through funding constraints and quality control or review. This aspect of the home health care industry needs an in-depth study. To the extent that demand is more responsive to supplier preferences, sociomedical needs become more acceptable as a criterion for formulating home health care policy. Despite their weaknesses, utilization data still provide important information, and the planning process will be better served if this information is used in conjunction with the needs approach.

Another criterion that can be used is the appraisal of the methods of forecasting by the reliability of results. Although it is not feasible to judge in advance the results of any forecasting techniques, their reliability can be tested on a priori basis by use of the following properties (*12*):

- explicit and reasonable assumptions,
- use of local data,
- proper specifications,
- use of reliable predictor variables, and
- replicability of estimates.

Of the four approaches considered in this study, the Rhode Island model comes closest to defining what "need" means in the home health care context. The HSA/SP and Florida models are not explicit about the underlying definition of need.

The specifications of a model in econometrics consists of a formulation of the equation and of statements or assumptions concerning the independent variables and the "disturbance" term (*13*). A specification error can result when the formulation of the equation or one of the underlying assumptions is incorrect. Specification error can be due to, for example, omission of relevant explanatory variables or inclusion of an irrelevant explanatory variable. The HSA/SP model is incorrectly specified because it excludes age composition, and both the HSA/SP and Florida models fail to consider patients in long-term care institutions who can be transferred to HHC programs. It is not clear from these two models whether the patients entering the HHC system via nonhospital routes include people who are inappropriately placed in long-term care institutions and should instead have been in HHC. Exclusion of these people tends to underestimate the actual need for HHC. Therefore, an attempt must be made to estimate the proportion of such patients who can be transferred to HHC.

A number of published reports purport to measure the percentage of long-term care residents who are unnecessarily institutionalized. Percentage estimates range from 15 to 40 (*14*). The health systems agencies should attempt to estimate these proportions for each county in their planning areas. However, such estimates may be difficult because of differing medical criteria for determining admissions to HHC.

The HSA/SP model makes the least demand on local data, the health status approach of Rhode Island makes the most demand, and the other two techniques make moderate use of these data.

The reliability of the estimated HHC forecast depends on the reliability of the predictor variables used to develop the forecast. A forecasting model that depends on predictor variables, whose future values are based on guesses and therefore probably unreliable, is not likely to produce a reliable forecast. The value of K_1 (proportion of hospital discharges transferred to HHC) and K_2 (admission to HHC from community sources) is unlikely to be determined accurately because of varying medical and organizational criteria for HHC admission. As of now, no standard practice governs admissions, which are likely to be influenced by provider and organizational preferences, socioeconomic characteristics of the patients, reimbursement practices, and other factors.

Demographic variables enter as predictor variables in all four models reviewed here. In general, they are the most desirable predictor variables for three reasons: (*a*) demographic variables such as age and sex are good proxies of health status, (*b*) interactions among demographic variables such as fertility, mortality, and age structure are well understood, and (*c*) forecasts of local area populations are becoming increasingly available.

Forecasting models, however, differ in the amount of demographic detail incorporated in them. For example, the HSA/SP and Florida models use forecasts of only the total population size. The health status and utilization approaches are the most sophisticated in their use of detailed demographic information.

Conclusions

The forecasting techniques analyzed here have not been studied systematically. I hope that this study will foster such research. Each approach should be tested in an a priori fashion. In addition, each approach should be refined by research indicating the difference between need and utilization under differing conditions of supply. To guide such research, I recommend a dialectic framework for integrating need and demand approaches.

A dialectic framework is an example of conflictual, synthetic systems (*15*), which allow a planner to build at least two completely antithetical representations of the problem. Need and demand constitute such opposing representations of the health care system. Need approaches are concerned with "what ought to be?" while demand approaches are concerned with "what is?". The decision maker, by examining contrasting views, will be in a better position to form his or her view of the problem that is a "creative synthesis" of two opposing approaches. Thus, need and demand approaches should be used jointly to produce a range estimate.

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SYNOPSIS

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Three models for forecasting home health care (HHC) needs are analyzed: HSA/SP model (Health Systems Agency of Southwestern Pennsylvania); Florida model (Florida State Department of Health and Rehabilitative Services); and Rhode Island model (Rhode Island Department of Community Affairs). A utilization approach to forecasting is also presented.

In the HSA/SP and Florida models, need for HHC is based on a certain proportion of *(a)* hospital admissions and *(b)* patients entering HHC from other sources. The major advantage of these models is that they are relatively easy to use and explain; their major weaknesses are an imprecise definition of need and an incomplete model specification.

The Rhode Island approach defines need for HHC in terms of the health status of the population as measured by chronic activity limitations. The major strengths of this approach are its explicit assumptions and its emphasis on consumer needs. The major drawback is that it requires considerable local area data.

The utilization approach is based on extrapolation from observed utilization experience of the target population. Its main limitation is that it is based on current market imperfections; its major advantage is that it exposes existing deficiencies in HHC.

The author concludes that each approach should be tested empirically in order to refine it, and that need and demand approaches be used jointly in the planning process.